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ABSTRACT

This paper reports on a study which was conducted to determine the impact of color on learning. The entire seventh-grade class from a Midwest junior high school was used in the study. Each student was randomly assigned into one of four treatment groups: (1) color-cued presentation, color-cued assessment; (2) color-cued presentation, black/white assessment; (3) black/white presentation, color-cued assessment; (4) black/white presentation, black/white assessment. During their homeroom session, all students received directions via audiotape; they then, in isolation, read and studied the graphic presentation summarizing a little-known Norse myth. Finally, they demonstrated both immediate recall and two week delayed retention on the graphic assessment without the aid of the presentation graphic. By reviewing the mean performance at recall and retention as a function of the type of presentation graphic, it was determined that the preferred presentation type was color-cued. There was one major finding of the study: the important factor in enhancing performance appeared to be the presence of a systematic color cue in graphic presentation. (Contains 15 references.) (JLB)

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From Color Code to Color Cue: Remembering Graphic Information

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From Color Code to Color Cue: Remembering Graphic Information

Peggy A. P. Pruisner

"Like a richly colored flame whose bright tip draws upward, but is brushed by erring storm, then relentingly seeks the earth's dark form and buries its deep desires bit by bit."

With these words, the poet Hilda A. Dammirch (1948) figuratively recounted the memory of her mother's life and death. This image of existence leaves a visual impression in the mind's eye; the vivid, imagined colors of the flame leave a sensation in the observer's sensory system. Whether in the aesthetic expression of a poem, the brush stroke of a painter, or the graphic design of a textbook, the written text of a tabloid, or merely the onslaught of optical information that bombards the eye from the moment of awakening to the rest of sleep, 80% of all information perceived is of a visual nature. Because visual data consist primarily of shape data and color data, one can assume that 40% of all information perceived consists of information about color (Kueppers, 1982). Despite its significance as a source of information and as an aesthetic expression, students learn little about color in school. A minimum of direct instruction may include information about the color spectrum, the color circle, the laws of color mixing, and a few references to the uses of color in literature; however, instruction concerning the understanding and use of color in learning is largely missing from the curriculum of elementary and secondary schools, colleges and technical schools (Kueppers, 1982; Robinson, 1991).

This is the third study in a line of research to determine the impact of color on learning. The initial study (Pruisner, 1992), "The Effects of the Use of a Color Code in Graphic Presentation and Assessment on the Reader's Immediate Recall and Delayed Retention," evolved from the researcher's concern for the increasing requirements of literacy (Venezky, 1990); among those requirements is visual literacy, the ability to understand and make visual messages (Dondis, 1973). This line of research has focused on the potential for and reluctance of educators to manipulate and interact with the features or characteristics of graphics and to consider instruction aimed at

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developing visual literacy as essential across the curriculum (Robinson, 1991).

It is not so surprising that the curriculum lacks instruction in the understanding and use of color because research does not clearly guide instruction. From the noteworthy, classic studies of Dwyer and Lamberski (1982-83) has evolved a body of research based on the study of color-coded materials of the chambers of the heart. Subsequent studies have researched the effects of visual attributes on learning and made recommendations for practitioners (Dwyer 1978, 1987) although a limited number of graphic forms have been used. These studies have attempted to broaden the scope of research by using a unique graphic for which subjects have no prior schema. Additionally, the second study (Pruisner, 1993) attempted to further isolate color as applied to learning from graphics by eliminating the oral retelling of the myth used prior to the reading of the myth and accompanying the graphic in the first study. This third study utilized the same color-coded plan in preparing the graphic for presentation and assessment, but the code was not explained to the students. Consequently, the color appears as a cue rather than a code.

Methodology

Statement of the problem

In response to the contemporary reader's need to interpret graphics in our broad information environment, research stresses the need for and importance of well-designed graphics (Gerber, 1985; Kostelnick, 1988; Peterson, 1983). Empirical research needs to be conducted to determine the effects of the manipulation of graphic features on reading (Hartley, 1986), graphical comprehension (Peterson, 1983; Soderston, 1983), and instruction.

Research Questions

The following research questions were investigated in both the initial research in reference to a color code and in this subsequent study to a color cue:

1. Is there a significant interaction among the graphic presentation type (systematically color-cued or black/white), the graphic assessment type (systematically color-cued or black/white), and the time of testing (immediate recall or delayed retention) of verbal material?

2. Is there a significant interaction between the graphic presentation type (systematically color-cued or black/white) and the graphic assessment type (systematically color-cued or black/white) when immediate recall of verbal material is tested?

3. Is there a significant interaction between the graphic presentation type (systematically color-cued or black/white) and the graphic assessment type (systematically color-cued or black/white) when delayed retention of verbal material is tested?

4. Is there a significant difference in recall of verbal material between those given a systematically color-cued graphic presentation and those given a black/white graphic presentation?

5. Is there a significant difference in retention of verbal material between those given a systematically color-cued graphic presentation and those given a

black/white graphic presentation?

6. Is there a significant difference in recall of verbal material between those given a systematically color-cued graphic assessment and those given a black/white graphic assessment?

7. Is there a significant difference in retention of verbal material between those given a systematically color-cued graphic assessment and those given a black/white graphic assessment?

Research Design

An analysis of variance for repeated measures was used to test the hypotheses that significant interactions and differences would occur. The independent variables manipulated were the type of graphic presentation, the type of graphic assessment, and time of testing. The two presentation and assessment types were systematically color-cued and black/white, and the two times of testing included immediate recall and 2-week delayed retention. The dependent variable, recall/retention on the assessment graphic, was measured by achievement, the number of characters, actions, and explanations that were remembered and recorded as stated on a graphic presentation summarizing a little-known Norse myth. To accommodate three independent variables, with two levels each, a 2x2x2 (presentation x assessment x time of testing) factorial design with repeated measures on the final factor was used. Presentation type and assessment type were the between-subjects factors, and recall/retention was the within-subjects factor.

Subjects

The entire seventh-grade class from a Midwest junior high school with 563 students in grades 7-9 was used in this study. Each of nine seventh-grade homerooms, containing a total of 176 students, was randomly assigned to one of four treatment groups (adjusted $n = 25$).

Treatment Groups

The four treatment groups received the following:

1. Color-cued presentation, color-cued assessment
2. Color-cued presentation, black/white assessment
3. Black/white presentation, color-cued assessment
4. Black/white presentation, black/white assessment.

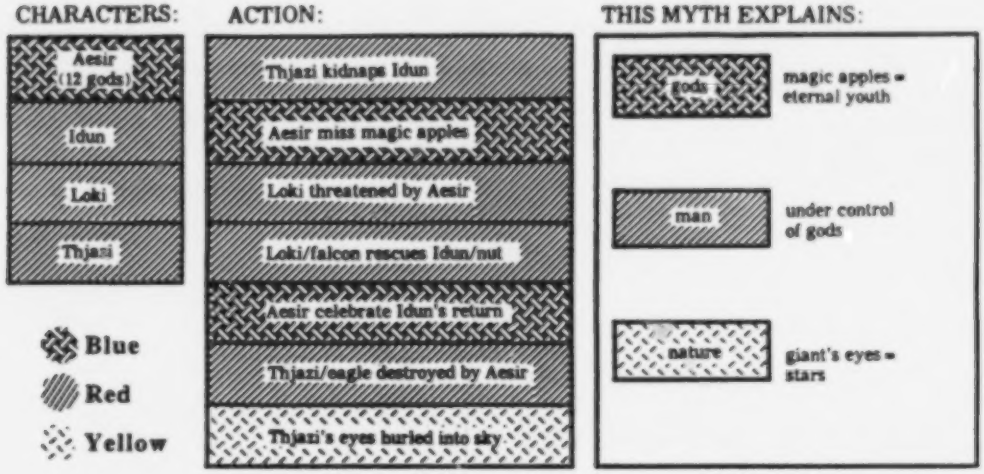
Procedure

During their homeroom session, all students received directions via audiotape; they then read and studied the graphic presentation in isolation. Finally, they demonstrated both immediate recall and 2-week delayed retention on the graphic assessment without the aid of the presentation graphic.

Materials

Following the directions, subjects were given the presentation graphic. The graphic design was the same on all presentations and assessments (see Figure 1). The form of the graphic was a unique design created by the researcher to prevent the subjects from having prior experience with the graphic.

Figure 1. Sample of graphic presentation indicating the use of color.



Scoring of the instrument

All assessments were scored by two raters to ensure accuracy. One point was given for each correct word or acceptable synonym. One point was given for each box or area where all words were written in order and spelled correctly. One point was given for each word or phrase that was placed in the correct box or area.

Results

Based on the results of the analysis of variance with the level of significance established at the .05 level, there was not a significant three-way interaction among the graphic presentation and the graphic assessment and the time of testing (see Table 1). The supporting evidence, the means and standard deviations for the four treatment groups, is graphically displayed in Table 2.

Table 1.

Repeated Measures Analysis of Variance, MANOVA Test Criteria and Exact F Statistics

	Value	F	Prob.	Sig.
Time x presentation	.99	.62	.67	NS
Time x assessment	.99	1.88	.17	NS
Time x presentation x assessment	.99	.01	.94	NS

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Table 2.

Mean Performance at Recall and Retention for Each Treatment Group

Group	Time of Testing			
	Recall		Retention	
	M	SD	M	SD
Color presentation				
Color assessment	59.68	(15.70)	24.36	(20.00)
Black/white assessment	57.16	(17.83)	17.20	(16.05)
Black/white presentation				
Color assessment	44.24	(20.88)	11.20	(12.55)
Black/white assessment	51.81	(13.45)	14.60	(12.65)

Note. n = 25 for each group.

Furthermore, the analysis of variance for between subjects effects did not indicate the presence of a significant two-way interaction between presentation type and graphic assessment type. However, presentation alone was a significant factor (see Table 3).

Table 3.

Analysis of Variance, Tests of Hypotheses for Between Subjects Effects

Source of of variation	df	Sum of squares	Mean square	F	Prob.	Si
Presentation	1	4176.98	4176.98	10.18	.00	SIG
Assessment	1	5.12	5.12	.01	.91	NS
Presentation x Assessment	1	1331.28	1331.28	3.25	.07	NS

By reviewing the mean performance at recall and retention as a function of the type of presentation graphic, it can be determined that the preferred presentation type was color-cued (see Table 4).

Table 4.

Mean Performance at Recall and Retention as a Function of Type of Presentation Graphic

	Presentation Type	
	Color	Black/white
Recall	58.42	48.03
Retention	20.78	12.90

Note. n = 50 for each group.

Consequently, there was one major finding of this study: the important factor in enhancing performance appeared to be the presence of a systematic color cue in graphic presentation.

Recommendations for Practice

Because the use of color had an impact on the recall of verbal information presented in graphic form, the use of color in graphics should be considered when developing curriculum, planning instruction, and designing text. Designers, teachers, and students must let the purpose of the graphic determine the color code. The code should be thoughtfully created to enhance and extend schema development and facilitate learning and retention of verbal material and thereby promote literacy.

Implications for Future Research

To continue this line of research, it is recommended that future study include the following:

1. Research should be conducted to investigate the use of color by readers of varying ages and skill levels in remembering patterns in schemata. This research should include quantitative as well as qualitative, ethnographic research and case studies of readers considered to be at an expert level. The results would have implications for the graphic schema strategies we teach to students.

2. Research should include the use of color codes and color cues in other graphic presentations and assessments to see if similar results are produced using a variety of both new and familiar graphic presentations and assessments.

3. Research should include experimentation with colors, the quality characteristics of colors, and the number of colors coded and cued in graphic background and print to see what impact these variables have on immedicate recall and delayed retention.

4. Finally, there should be further research into the other features of graphic presentation and assessment to determine the comparative efficacy of other

graphic features in tapping and developing schemata. This research should indicate where other features in the graphic design are effective in increasing immediate recall and delayed retention of verbal material presented in graphic form.

The results of further research would provide valuable information for designers, teachers, and readers of materials at all levels of the learning spectrum.

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